

**ABSTRACT OF THE DISCLOSURE**

A triple-pump coherent anti-Stokes Raman scattering (CARS) system for simultaneous measurements of temperature and species concentrations with high spatial and temporal resolution is described, wherein four laser beams generate CARS signals near two distinct wavelengths exhibiting an N<sub>2</sub> CARS signal along with the CARS signal from another target molecule, each pair of CARS signals generated over a relatively narrow wavelength region and captured with fixed-wavelength detection. Temperature and relative concentrations of the target species with respect to N<sub>2</sub> are extracted by fitting the measured CARS spectrum in each wavelength region is described that in its essential components includes